Remarks

Claims 1-20 are pending in the present application. It is respectfully submitted that the pending claims define allowable subject matter.

Claims 1-20 are rejected under 35 USC § 103(a) as being unpatentable over Sheehan et al. (USP 6,106,466) ("Sheehan") in view of Yamauchi (USP 7,110,583) ("Yamauchi"). Applicants respectfully traverse these rejections for at least the reasons set forth hereafter.

Claim 1 recites an apparatus for detecting a contour of an object within an image, comprising "a user interface for selecting first and second points within an object, said object being within an image" and "a processor for detecting first and second subcontours based on said first and second points, respectively, said first and second subcontours being based on detected edges, said processor combining said first and second subcontours into a contour." Sheehan and Yamauchi, however, both rely on fundamentally different methods for detecting a contour.

Turning first to Sheehan, Sheehan does not disclose the recitation of selecting first and second points within an object, said object being within an image. As referenced in the Office Action, Sheehan states that "the user manually selects a representative subset of the imaging planes for tracing. The resulting borders are input into the reconstruction algorithm to produce a three-dimensional surface, which estimates the surface that would be obtained using borders traced from all imaging planes in the data set." (Col. 13, lines 28-29). Applicants submit that tracing borders on a representative subset of imaging planes is completely different than selecting first and second points within an object that is within an image.

Sheehan also does not disclose the recitation of detecting first and second subcontours based on said first and second points, respectively, said first and second subcontours being based on detected edges. Instead, Sheehan inputs the resulting borders data into the reconstruction algorithm that determines the contour in a fundamentally different way than the Applicants. The reconstruction algorithm of Sheehan does not estimate the surface based on detected edges, but instead relies on the use of a predetermined mesh model that is based on training data derived from other patients. The reconstruction algorithm uses "a set of training

data to derive a mesh model of an archetype heart that is subsequently adjusted so that its shape "explains" the shape of the patient's heart in the observed images." (Col. 12, lines 8-11). Specifically, "[a]s shown in a block 192 of FIG. 10, the knowledge base is created by manually tracing ultrasound images 190 of the hearts (e.g., the left ventricle) for this group of other individuals, producing the set of training data." (Col. 12, lines 24-27). Also, "[e]ach ventricular surface for the images comprising the training data is represented by an abstract three-dimensional triangular mesh." (Col. 12, lines 43-45). Therefore, the resulting three-dimensional surface that results from the work of the reconstruction algorithm at block 194 of FIG. 10 is based on the abstract mesh derived from the training data. Sheehan does not, therefore, estimate the surface based on detected edges. In addition, as Sheehan does not disclose the recitation of detecting first and second subcontours based on said first and second points, respectively, Sheehan does not disclose the recitation of combining said first and second subcontours into a contour. Therefore, claim 1 is patentable over Sheehan.

Turning to Yamauchi, there is no suggestion to combine Yamauchi with Sheehan, as Yamauchi teaches away from any user input when detecting contours. Yamauchi states that "the operator can benefit from the present invention in that operations that conventionally require the operator's involvement are completely automated, and always-consistent diagnostic information can be obtained." (Col. 15, lines 33-36).

Furthermore, Yamauchi does not make up for the deficiencies of Sheehan. As Yamauchi does not detect contours based on input from the user, Yamauchi does not disclose the recitation of selecting first and second points within an object, and thus also does not disclose the recitation of detecting first and second subcontours based on said first and second points, respectively.

Yamauchi also generates a contour in a fundamentally different way than the Applicants' claimed invention. Yamauchi states that "[a]fter the image generating unit 110 and the image normalizing unit 111 generate a new ultrasound image, the automatic contour extracting unit 120 automatically extracts a contour of an object to be examined, such as a heart, within the ultrasound image by performing a predetermined operation on the ultrasound image." (Col. 9, line 63 – Col. 10, line 1). Yamauchi states that the automatic contour extracting unit 120

has the advantage of "automatically extracting the contour of the object from the ultrasound image without requiring the operator to perform an input operation." (Col. 10, lines 10-12).

Furthermore, Yamauchi does not disclose the recitation of said processor combining said first and second subcontours into a contour. The Office Action refers to FIGS. 24A-24C of Yamauchi. These figures, however, do not indicate combining first and second subcontours into a contour, but instead disclose a method for creating a third contour.

FIGS. 24A-24C display a contour surrounding a region generated by the OR operation and are a modification of FIGS. 23A-23C that calculate points using an average. (Col. 22, lines 48-57). Yamauchi states that "[w]hen the real-time contour extraction is not necessary ... it is alternatively possible to generate (estimate) an initial contour within an ultrasound image through interpolation using past results of extraction from a plurality of ultrasound images (of frames) which have been obtained immediately before and after the ultrasound image containing the initial contour to be estimated." (Col. 22, lines 31-39). Yamauchi further states that "FIGS. 23A-23C show a method for generating an initial contour through such interpolation. In FIGS. 23A-23C, contours are expressed from the oldest to newest as contours "A", "B", and "C". With this method, the initial contour "B" is generated (estimated) from two already extracted contours "A" and "C", which respectively correspond to times before and after a time corresponding to the ultrasound image containing the estimated contour "B"." (Col. 40-47). Therefore, the contour displayed on FIG. 24C and labeled "estimated initial contour B" is a separate contour on a different ultrasound image than the contours A and C displayed on FIGS. 24A and 24B, respectively. In other words, Yamauchi is not combining first and second subcontours into a contour, but is instead creating a third contour that is both based on the other two contours and separate from the other two contours.

The Office Action further refers to Col. 14, lines 7-13, where the dynamic contour extracting unit 122 uses the initial automatically generated contour and adjusts it based on an active contour model, such as by monitoring fluctuations of the energy "E" that is based on a curve. Also, in the cited Col. 14, lines 39-67, a new contour is estimated "of an object of interest within an ultrasound image by predicting movement (i.e. performing movement compensation) of the object from two sets of contour data which have been extracted by the dynamic contour

extracting unit 122 immediately before the initial contour to be estimated. For instance, the two sets of contour data preceded the initial contour by one frame and two frames, respectively." (Col. 14, lines 32-39). Therefore, rather than combining the first and second subcontours into a contour, Yamauchi creates an initial contour separate from the two sets of contour data that it is based upon. Therefore, claim 1 is patentable over Yamauchi, alone or in combination with Sheehan.

Turning to the independent claims 9 and 17, claim 9 recites "selecting a first point within an object using a user interface; identifying a first subcontour based on said first point; selecting a second point within said object using said user interface; identifying a second subcontour based on said second point; and defining a contour based on said first and second subcontours." Claim 17 recites "selecting points within said object using a user interface; searching for edges within said image around said points as said points are selected, said edges being representative of non-uniformities in said pixel or Voxel data, said edges defining subcontours around each of said points" and "combining said subcontours into a contour as each of said subcontours is defined." For reasons set forth above for claim 1, Sheehan and Yamauchi, alone or in combination, do not disclose the recitations of claims 9 and 17. Accordingly, claims 9 and 17 are patentable over Sheehan and Yamauchi.

Turning to the dependent claims, claim 3 recites "said processor further comprising a pre-set limit, said pre-set limit defining image subsets with respect to said first and second points, said processor searching said image subsets for said detected edges." As neither Sheehan nor Yamauchi disclose the recitation of the first and second points, it follows that a pre-set limit defining image subsets with respect to the first and second points is also not disclosed. The Office Action refers to Col. 9, lines 11-35 of Sheehan; however, this passage is directed to acquiring the ultrasound image data representative of a patient's heart. Also referred to is Col. 13, line 66 through Col. 14, line 15, which discusses calculating "the covariance matrix associated with the archetype shape." (Col. 13, lines 66-67). Sheehan states that "the anatomically allowable variations in ventricular shape are specified by an 81x81 covariance matrix 204 of a set of three-dimensional vertices for either the endocardial surface or the epicardial surface." (Col. 13, lines 57-61). Sheehan's covariance matrix of a set of three-

dimensional vertices is clearly different than the Applicants' pre-set limit defining image subsets with respect to said first and second points and thus claim 3 is patentable.

Applicants' claim 7 recites "said user interface further comprising an input for deselecting a point within said contour, said processor defining an updated contour excluding said point." Neither Sheehan nor Yamauchi disclose the recitation of an input for deselecting a point within said contour. The Office Action refers to Col. 16, line 65 through Col. 17, line 12 of Sheehan, where Sheehan measures "whether the last adjustment to the control vertices of the mesh model improved the match between features extracted from the predicted images and the observed images of the patient's heart." (Col. 16, line 65 – Col. 17, line 1). Also, "[t]he adjustments to the shape of the mesh model is constrained by the knowledge base embedded in the mesh model." (Col. 17, lines 5-7). Therefore, the adjustment of Sheehan is based on the knowledge base (i.e. archetype shape and covariance matrix reflecting the most probable shape, such as of the left ventricle) and not on an input for deselecting a point within the contour. Accordingly, claim 7 is patentable.

Moreover, dependent claims 2-8, 10-16 and 18-20 are allowable based at least on the dependency of these claims from the independent claims.

In view of the foregoing remarks, it is respectfully submitted that the prior art neither anticipates nor renders obvious the claimed invention and the pending claims in this application are believed to be in condition for allowance. Reconsideration and favorable action is respectfully solicited. Should anything remain in order to place the present application in condition for allowance, the Examiner is kindly invited to contact the undersigned at the telephone number listed below.

Respectfully Submitted,

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